

CLAIMS**What is claimed is:**

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- 1 1. A method for utilizing a plurality of transmitters to determine one or more location
2 characteristics of a body, said plurality of transmitters producing a plurality of RF carrier
3 signals, said method comprising:
4 mounting one or more distributed antennas to said body, each of said one or more
5 distributed antennas having a non-unique phase center;
6 receiving said plurality of RF carrier signals from said plurality of transmitters with
7 said one or more distributed antennas; and
8 determining said one or more location characteristics of said body.
- 1 2. The method of Claim 1, wherein said step of determining further comprises utilizing
2 carrier phase measurements for determining said one or more characteristics of said body.
- 1 3. The method of Claim 1, wherein said one or more location characteristics comprises
2 a position of said body.
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1 4. The method of Claim 1, wherein said one or more location characteristics comprises
2 an attitude of said body:

1 5. The method of Claim 1, wherein each of said one or more distributed antennas has a
2 substantially spherical coverage.

1 6. The method of Claim 1, wherein at least a portion of a view of said one or more
2 transmitters by said one or distributed antennas is blocked by said body.

1 7. The method of Claim 6, further comprising providing that each of said one or more
2 distributed antennas are circularly constructed with a respective physical origin.

1 8. The method of Claim 7, further comprising determining a vector from said respective
2 physical origin to a phase center for each of said plurality of transmitters.

1 9. The method of Claim 1, further comprising determining a distance between each of
2 said plurality of transmitters and each of a plurality of phase centers whereby each phase
3 center corresponds to one of said plurality of transmitters.

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1 10. The method of Claim 1, further comprising obtaining a coarse estimate of a position
2 of said body, and utilizing said coarse estimate for determining a unit vector related to a first
3 position vector of a physical center of said distributed antenna with respect to a reference
4 system and a second position vector between said body and a respective of said plurality of
5 satellites.

1 11. The method of Claim 10, further comprising utilizing said unit vector for obtaining
2 an improved estimate of a position of said body, and utilizing said improved estimate for
3 iteratively determining said unit vector more accurately.

1 12. The method of Claim 1, further comprising determining information related to a
2 phase center constellation comprised of a plurality of phase centers such that each phase
3 center in said phase center constellation is related to a respective of said plurality of
4 transmitters.

1 13. The method of Claim 12, further comprising determining a plurality of vector
2 magnitudes whereby each vector magnitude is related to a vector from a physical center of
3 said distributed antenna to one of said plurality of phase centers.

1 14. A method for utilizing a plurality of transmitters in a plurality of locations to
2 determine one or more location characteristics of a body, said method comprising:
3 mounting one or more distributed antennas to said body, each of said one or more
4 distributed antennas having a plurality of phase centers with respect to said plurality of
5 locations of said plurality of transmitters; and
6 determining one or more values related to said plurality of phase centers.

1 15. The method of Claim 14, further comprising:
2 determining one or more values related to a vector to a reference center of said body
3 with respect to a fixed coordinate system.

1 16. The method of Claim 15, further comprising:
2 determining one or more values related to a position vector from said reference
3 center to an i^{th} satellite.

1 17. The method of Claim 16, further comprising:
2 determining one or more values related to a vector from said reference center to a

3 phase center related to said i^{th} satellite.

1 18. The method of Claim 17, further comprising:
2 determining an attitude vector for said body.

1 19. The method of Claim 16, further comprising:
2 determining a unit vector for said body from said reference center with respect to an
3 i^{th} satellite.

1 20. The method of Claim 16, further comprising:
2 estimating a unit vector by obtaining an estimate of said position vector.

1 21. The method of Claim 20, further comprising:
2 reducing the error of said estimate of said unit vector by iteration.

1 22. The method of Claim 14, further comprising:
2 measuring a carrier phase from an i^{th} satellite, and adding a correction to said
3 measured carrier phase.

1 23. The method of Claim 22, wherein said correction is determined utilizing a known
2 attitude of said body.

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2 24. The method of Claim 22, wherein said correction is determined by making an
3 approximation of said position vector.

1 25. A system for determining location characteristics of a body utilizing a plurality of
2 spaced apart transmitters, said system comprising:
3 one or more antennas mounted to said body, each of said one or more antennas
4 having a non-unique phase center with respect to said plurality of spaced apart transmitters,
5 said one or more antennas providing a wide angle coverage for maintaining contact with said
6 one or more spaced apart transmitters; and
7 means for determining said location characteristics in response to reception of signals
8 from said spaced apart transmitters by said one or more antennas.

1 26. The system of Claim 25, wherein said means for determining said location
2 characteristics comprises utilizing one or more equations related to calculating a carrier
3 phase.

1 27. The system of Claim 25, wherein said means for determining said location
2 characteristics utilizes the following equation:

$$3 \quad \|v_i\|^2 = \|r_{si} - r_B\|^2 + \|r_{pi}\|^2 - 2\|r_{pi}\|\|r_{si} - r_B\|\cos(\beta_i)$$

4
5
6
7 where

$$8 \quad \cos(\beta_i) = \sin(\alpha_i) = \sqrt{1 - \left[\frac{(r_{si} - r_B) \cdot \hat{z}_B}{\|r_{si} - r_B\|} \right]^2}$$

9
10
11 and

$$12 \quad \hat{z}_B = \sin(\theta_B)[\hat{x}_e \cos(\phi_B) + \hat{y}_e \sin(\phi_B)] + \hat{z}_e \cos(\theta_B)$$

- 1 28. The system of Claim 25, wherein said means for determining said location
2 characteristics utilizes the following equation:

$$\|v_i\| = \|r_{si} - r_B\| - r_{pi} \cdot \frac{r_{si} - r_B}{\|r_{si} - r_B\|}$$

- 1 29. The system of Claim 25, wherein said means for determining said location
2 characteristics utilizes the following equation:

$$\|v_i\| = \|r_{si} - r_b\| - \|r_{pi}\| \cos(\beta_i)$$

- 1 30. The system of Claim 25, wherein said means for determining said location
2 characteristics utilizes the following equation:

$$\hat{r}_{sih} \approx \frac{r_{si} - \tilde{r}_b}{\|r_{si} - \tilde{r}_b\|}$$

- 1 31. The system of Claim 25, wherein said means for determining said location
2 characteristics utilizes the following equation:

3

$$\Delta = k \|r_{pi}\| \sin(\xi)$$

4

- 1 32. The system of Claim 25, wherein said means for determining said location
2 characteristics utilizes the following equation:

3

$$\Delta_j = \alpha_0 + k \|r_{pi}\| \sin(\xi), j = 1, \dots, N$$

- 1 33. A radiator system for determining location characteristics of a body utilizing a
2 plurality of spaced apart transmitters, said body having a curved surface, said radiator system
3 comprising:

4 one or more radiators mounted to said curved surface of said body so as to conform
5 to said curved surface, each of said one or more radiators having a non-unique phase center
6 with respect to said plurality of spaced apart transmitters, said one or more antennas
7 providing a wide angle coverage for maintaining contact with said one or more spaced apart
8 transmitters.

1 34. The radiator system of Claim 33, wherein said one or more radiators comprises a
2 circular ring.

1 35. The radiator system of Claim 33, wherein said one or more radiators comprises a
2 plurality of circular rings.

1 36. The radiator system of Claim 33, further comprising means for determining said
2 location characteristics in response to reception of signals from said spaced apart transmitters
3 by said one or more antennas.

1 37. The radiator system of Claim 33, wherein said means for determining said location
2 characteristics comprises utilizing one or more equations related to a carrier phase.

1 38. The radiator system of Claim 33, further comprising means for determining an
2 attitude of said body utilizing no more than two antennas wherein said body has three
3 attitude degrees of freedom.

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1 39. The radiator system of Claim 33, further comprising means for determining an
2 attitude of said body utilizing no more than one antenna wherein said body has two attitude
3 degrees of freedom.

1 40. The radiator system of Claim 33, wherein said one or more radiators maintain contact
2 with said plurality of spaced apart transmitters even when a portion of a view of said
3 one or more antennas to said plurality of spaced apart transmitters is blocked.

1 41. A method for carrier phase determination of location characteristics utilizing a
2 plurality of spaced apart transmitters, comprising:
3
4 mounting one or more antennas to a moveable body positioned among said plurality of
5 spaced apart transmitters such that said antennas maintain contact with each of said plurality
6 of spaced apart antennas as said attitude of said body changes without utilizing RF switches;
7 and
8
9 determining one or more values related to one or phase centers of said one or more antennas.

1 42. The method of Claim 41, further comprising determining an attitude solution for said
2 body when said body has three attitude degrees of freedom utilizing no more than two
3 antennas.

1 43. The method of Claim 41, further comprising determining an attitude solution for said
2 body when said body has two attitude degrees of freedom utilizing no more than one
3 antenna.

1 44. The method of Claim 41, further comprising providing that said one or more antennas
2 has wide angle coverage for simultaneous contact with said plurality of spaced apart
3 transmitters.